Efficiency of heterogeneous photo-catalysis (TiO_2) for the removal of an acidic pharmaceutical from liquid phase: case study diclofenac sodium

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The occurrence, fate and effects of pharmaceuticals compounds (PhCs) in the environmental system have attracted special attention as new emerging contaminants. PhCs have been identified and detected in wastewater, river water and even sewage sludge and soil at ng/L levels, which may cause a potential hazard for the aquatic environment [1-2].
Therefore, to protect the aquatic environment from the adverse effects of these hazard pollutants wastewater should be carefully treated. Moreover, special treatments are needed for wastewater recycling and reusing. For the scope, the search and development of more efficient treatment processes is of a vital importance, since the conventional wastewater technologies, including biological, thermal and physical treatments, have been found insufficient to destroy these pollutants, due to their low biodegradability and high chemical stability [3-4].
In this work the efficiency of heterogeneous photo-catalysis (TiO_2) for the removal of an acidic pharmaceutical, commercially available as diclofenac sodium (2-[2-(2,6-dichloroanilino)phenyl] acetic acid), was investigated [5].
Diclofenac sodium is known as non-steroidal anti-inflammatory drug (NSAIDs), and is extensively used as non-prescription drug, used to treat inflammation and pain, mostly those associated with arthritis [6].
The experiments were performed using a solar simulator (Suntest CPS) furnished with Xenon lamp. TiO_2 catalyst was used since it is considered the most active semi-conducting material, strongly resistant to chemical- and photo-corrosion, safely handled, and low cost. The overall results showed approximately complete degradation of diclofenac sodium after 8 hours.
Kinetic studies were accomplished when the initial concentration was 22.46 mg/L. The degradation process of diclofenac sodium could be depicted by first order reaction kinetics as described in Fig.1, and table 1. Half-time of the degradation process was obtained from the kinetic equation.

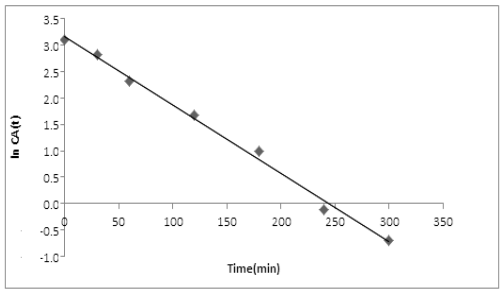

Figure 1. Degradation kinetics of diclofenac sodium in water under xenon lamp irradiation, using TiO_2 as catalyst. C(t), concentration at time t in mg/L.

The identification of the photoproducts was performed by using liquid chromatography coupled with mass spectrometry (LC-MS) and many photoproducts were detected and identified. The overall results suggest that using heterogeneous photo-catalysis (TiO_2) for the removal of pharmaceuticals compounds from wastewater may be promising in the protection of environmental system from these emerging contaminants.

Table 1. First order transformation kinetics

Time (min)	0	30	60	120	180	240	300
Conc. (mg/L)	22.5	16.8	10.3	5.4	2.7	0.9	0.5
LnC	3.12	2.82	2.33	1.68	0.99	-0.105	-0.683

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